Letter Health Consultation

Offsite Vapor Intrusion Investigation

TOASTMASTER FACTORY PROPERTY

MACON, MISSOURI

Prepared by
Missouri Department of Health and Senior Services

OCTOBER 8, 2014

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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LETTER HEALTH CONSULTATION

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Re: Letter Health Consultation, Toastmaster – Macon Site, Offsite Vapor Intrusion Investigation

Dear Ms. Wilder:

At the request of the Missouri Department of Natural Resources (DNR), the Missouri Department of Health and Senior Services (DHSS), in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), has reviewed the results of the July 2014 vapor intrusion (VI) sampling at 19 residences adjacent to the former Toastmaster factory property in Macon, Missouri. Specifically, DHSS has reviewed trichloroethylene (TCE), dichloroethylene (DCE), and vinyl chloride (VC) concentrations in indoor air, crawlspace air, and subslab soil gas samples to evaluate potential human health risks of inhalation exposure to TCE and its degradation products that may be migrating offsite and intruding as vapors into homes.

DHSS concludes that TCE vapor intrusion poses current or future health concerns for occupants at two of the sampled residences. At one residence (location 114), current exposure to TCE found in indoor air (11 $\mu g/m^3$) poses an immediate health concern. This presents a public health hazard that needs to be addressed in a timely fashion. At the other residence (location 116), TCE concentrations in subslab soil gas exceed screening levels by three orders of magnitude and, thus, could pose future health concerns for occupants as a result of TCE accumulating in indoor air. Of primary concern is cardiac malformation in a developing fetus due to short-term (i.e., three weeks or less) maternal exposure to TCE, particularly during the first trimester of pregnancy. Of additional concern are adverse effects on the immune system and kidneys that could result from several months of exposure to TCE in adults and children. Cancers associated with lifetime exposure to low concentrations of TCE include kidney and liver cancers and non-Hodgkins lymphoma. DCE and VC were not found to be at levels of health concern in any of the residential samples.

Based on potential short-term health risks associated with TCE exposure, DHSS recommends prompt mitigative action at residences where TCE from vapor intrusion poses current or future health risks.

This includes the residence where TCE in indoor air is an immediate health concern (location 114), as well as the residence where high concentrations of TCE found in subslab soil gas might accumulate to levels of health concern in indoor air (location 116). DHSS recommends implementation of appropriate operation, maintenance, and monitoring plans necessary to support the short and long term performance of any selected mitigation methods (1). Taking into consideration the limitations of a single VI sampling event, DHSS also recommends additional VI sampling at other residences. Currently, the data provide an incomplete understanding of the extent of vapor migration at the site and do not account for potential seasonal variations in VI. To assist DNR and the community, DHSS is available to review additional sampling data, provide guidance on potential health risks, and answer questions about possible health effects.

Screening Level Comparison

In this evaluation, DHSS compared TCE concentrations in indoor and crawlspace air samples to indoor air guidelines developed ATSDR [i.e., ATSDR's chronic minimal risk level (MRL) and cancer risk evaluation guide (CREG)] and EPA [i.e., EPA's reference concentration (RfC)] (2, 3). TCE concentrations in subslab soil gas samples were compared to ATSDR's and EPA's subslab soil gas screening levels, which were derived from the indoor air guidelines and are used in determining a need for additional action or follow-up sampling (4, 5). Table 1 shows TCE concentrations in indoor air and subslab soil gas that exceed these screening levels.

Table 1. Elevated TCE Concentrations (µg/m^3) in Residential Indoor Air and Subslab Soil Gas*

Sample Type	Locations where TCE Detections Exceeded Health-Based Screening Levels[a]	Maximum TCE Concentration Detected (µg/m^3)	Health-Based Screening Levels (µg/m^3)
Indoor Air	111	**0.27**	2.0 (noncancer)[b] 0.24 (cancer)[c]
	114	**11**	
	116	**0.42**	
Subslab Soil Gas	111	<1.2	4.8 (cancer, EPA)[d] 2.4 (cancer, ATSDR)[e]
	114	**38**	
	116	**6,700**	

*Missouri Department of Natural Resources, July 2014; values in **bold** exceed screening levels

[a] Two or more indoor air samples were collected by DNR at 19 residences; two or more subslab soil gas samples were collected by DNR at 8 of those residences plus an additional garage.
[b]ATSDR's chronic MRL and EPA's RfC, which are concentrations unlikely to cause adverse non-cancer health effects (2, 3)
[c]ATSDR's CREG, which is a concentration expected to cause no more than 1 additional cancer case in 1 million exposed people (3)
[d]EPA's subslab screening level, based on their indoor air cancer risk guideline for a residential scenario (0.48 µg/m3) and recommended subslab soil gas attenuation factor of 0.1 (5)
[e]ATSDR's subslab screening level, based on CREG (0.24 µg/m3) and EPA's recommended subslab soil gas attenuation factor of 0.1 (5)

At one residence (location 114), TCE concentration in indoor air exceeded the screening level for noncancer health effects (2.0 µg/m^3; ATSDR's chronic MRL and EPA's RfC). Because VOC concentrations in ambient air were below detection limits (data not shown), and because TCE concentrations in subslab soil gas at that location exceeded the subslab screening levels (2.4 µg/m^{3}and 4.8 µg/m^3) by an order of magnitude, TCE in indoor air at that residence is believed to be primarily related to vapor intrusion.

At another residence (location 116), TCE concentrations in subslab soil gas exceeded the target subslab screening level by more than three orders of magnitude. Although the TCE level in indoor air at that residence did not exceed the noncancer screening level, elevated subslab soil gas concentrations indicate that TCE could, in the future, accumulate in indoor air to levels of immediate health concern.

At a third residence (location 111), TCE in indoor air was found to exceed a cancer screening level (0.24µg/m^3; ATSDR's CREG). However, because TCE in subslab soil gas did not exceed subslab screening levels, a complete vapor intrusion pathway is not evident from the available data. It is possible that indoor sources could be contributing to the TCE in indoor air at that location. EPA has determined that 50% of homes in urban areas have TCE concentrations up to 1.1 µg/m^3 in indoor air due to the common home use of commercial products that contain TCE (6).

TCE concentrations at other locations either did not exceed screening levels or were below detection levels. However, vapor intrusion rates can fluctuate with changes in season and use of heating and cooling systems. At other times of the year, indoor air TCE levels could be higher (or lower) than those found during this single sampling event.

Effects of Exposure to VOCs of Concern

EPA's RfC for inhalation of TCE is based on studies showing development of cardiac malformations in rats over approximately three weeks of gestational exposure and immunological effects in mice after 30 weeks of exposure (2). In their review of those studies, EPA derived TCE concentrations that might be expected to have the same effects in humans (see Table 2). The 99th percentile of these human equivalent concentrations (HECs) are 21 µg/m^3 TCE for short-term exposures potentially associated with cardiac malformations and 190 µg/m^3 TCE for chronic exposures potentially associated with immunological effects (2). In 2013, ATSDR adopted EPA's RfC as its chronic MRL (3).

At the residence where TCE in indoor air was found to exceed the noncancer screening level (location 114), the TCE concentration (11 µg/m^3) approaches the estimated HEC for fetal cardiac malformations (21 µg/m^3). If TCE concentrations fluctuate, indoor air TCE levels could exceed the HEC. This indicates that pregnant women exposed to TCE in indoor air at that residence are at increased risk of cardiac malformations in their developing fetus. Of particular concern are short-term exposures that might occur during fetal heart development in the first trimester of pregnancy.

Because VOC concentrations in indoor air have not been regularly monitored, DHSS cannot draw definitive conclusions about the potential health concerns due to chronic (long-term) exposures at residences near the Toastmaster Macon site. However, limited sampling data collected in 1996 (7) give some indication of possible long-term exposures at the site. In comparing the past and current data, DHSS considers chronic TCE exposure to be a possibility at location 114, where current and past TCE

concentrations in indoor air (11 µg/m^3 in 2014; 25 µg/m^3 in 1996) exceed the current noncancer screening level. At that residence, TCE concentrations fall within a range of uncertainty applied to the HEC for immunological effects (i.e., from 1.9 µg/m^3 to 190 µg/m^3). In addition, the TCE concentration at that location in 1996 approaches the concentration associated with adverse kidney effects (30 µg/m^3) in a study used to support establishment of the RfC (2). If TCE concentrations fluctuate, long-term indoor air TCE concentrations could exceed approach or exceed HECs. Potential long-term exposure concerns include adverse effects on the kidneys and immune system in adults and children.

Table 2. Derivation of the Reference Concentration for TCE

	Noncancer Screening Level[a] (µg/m^3)	**Principal Studies** **Human Equivalent Concentrations[b] (µg/m^3)**	
TCE	2.0	cardiac malformations	21
		immunological effects	190

[a]RfC established by EPA in 2011 (2) and adopted by ATSDR as its chronic MRL in 2013 (3)
[b]RfC derived by application of uncertainty factors (10 for cardiac malformations to account for interspecies extrapolation and human variability; 100 for immunological effects to account for interspecies extrapolation, human variability, and the use of a lowest observed adverse effect level) to 99th percentile human equivalent concentrations.

Interpretation of epidemiological data supporting an association between TCE and cardiac malformations has been controversial. Some epidemiological studies have reported no significant increases in congenital cardiac malformations following maternal exposure to TCE (8). While EPA acknowledges that there are limitations to the animal study used in developing the RfC, the results of the selected animal study are believed to be supported by the general weight of evidence from multiple epidemiological and other studies that TCE exposure in humans may cause a variety of cardiac defects (8).

Additional studies have provided substantial evidence that, at sufficient dose and exposure duration, TCE is toxic to the nervous system, kidney, liver, and male reproductive system and is associated with other developmental effects (3). The most sensitive effects of TCE exposure appear to be developmental effects (including fetal cardiac malformations), kidney toxicity, and immunological effects (2). Immunological studies, including epidemiological studies, indicate that chronic exposure to a sufficient dose of TCE may increase the risk of development of autoimmune diseases and hypersensitivity skin disorder, as well as possible suppression of the immune system (8). These include inflammatory diseases and scleroderma, a hardening of the skin.

EPA classifies TCE as carcinogenic to humans. The National Toxicology Program (NTP) has determined that TCE is reasonably anticipated to be a human carcinogen based on evidence from animal studies and limited evidence from human studies (9). Long-term TCE exposure is associated with liver and kidney cancers and non-Hodgkins lymphoma by multiple routes, including inhalation exposure (2, 3). Because kidney cancer may develop by a mutagenic route of exposure to TCE, there is increased cancer risk from exposure to TCE during childhood (2, 3).

In this evaluation, a range of cancer risks was determined from the highest and lowest TCE concentrations found in residential indoor air (11 µg /m^3 and 0.27 µg /m^3), using EPA's inhalation unit risk factor and EPA's Age-Dependent Adjustment Factors (ADAFs) to account for increased early-life susceptibility to kidney cancer (2):

Cancer Risk = Air Concentration × Inhalation Unit Risk Factor (IUR) × ADAFs
where, IUR = 4.1×10^{-6} (µg /m^3)$^{-1}$

Cancer Risk$_{(high)}$ = (11 µg /m^3) × (4.1×10^{-6} (µg /m^3)$^{-1}$) × ADAFs
= 5.2×10^{-5}
Cancer Risk$_{(low)}$ = (0.27 µg /m^3) × (4.1×10^{-6} (µg /m^3)$^{-1}$) × ADAFs
= 1.3×10^{-6}

These values represent possible increased cancer risks from lifetime exposure to TCE in the indoor air, ranging from approximately 1 excess case in a population of 1,000,000 to approximately 5 excess cases in a population of 100,000 exposed to the same concentration over a lifetime. However, actual exposures have not been constant over individuals' lifetimes. Exposures are likely intermittent, rather than 24 hours per day/7 days per week, and have not lasted a lifetime (i.e., 70 years). Also, exposures have likely varied over time due to changes in the rates of vapor intrusion. Because long-term exposure levels are not known, DHSS cannot draw definitive conclusions about cancer risks at the Toastmaster Macon site.

Recommendations

To protect the current and future health of individuals living near former Toastmaster factory property, DHSS recommends the following:

- Quickly reduce occupant exposures by using engineering controls, such as vapor intrusion mitigation systems, at residences where vapor intrusion is found to pose a potential health concern. Swift action is recommended at residences where TCE concentrations in indoor air, crawlspace air, or subslab soil gas are found to pose current or future health risks (i.e., locations 114 and 116). Appropriate operation, maintenance, and monitoring plans for the selected technology are recommended.

- Sample residences in multiple seasons to account for seasonal changes in the rate of vapor intrusion.

- Expand the off-site VI sampling area in a systematic effort to swiftly determine the extent of TCE vapor migration and intrusion at the site.

- Concurrently collect sub-slab soil gas, indoor air, and ambient air samples. The collection of multiple types of data is generally recommended to accurately and precisely define whether potential VI pathways may be complete. Concurrent sampling allows for data comparison and complete assessment of the risks from the complete vapor intrusion pathway, as well as timely response to any health hazards. Ideally, samples in residences should be collected for a continuous period of 24 hours.

- Fully characterize the site to determine the extent of VOC migration from the TCE source zone and any other sources of contamination and to identify any neighboring commercial and/or residential buildings at risk of VI.

To assist the Macon community:

1. DHSS in collaboration with DNR has spoken with residents and distributed fact sheets about vapor intrusion and TCE exposure. DHSS is available to answer people's questions about the health and the health of their children as they arise.

2. DHSS is available to review additional sampling data and site information as they become available and, if necessary, provide guidance regarding possible health risks

3. DHSS is available to provide health education and literature when requested.

We appreciate the opportunity to be of assistance. If you have any questions, please contact Elizabeth Semkiw at (573) 751-6102.

Sincerely,

Jonathan Garoutte, Chief
Bureau of Environmental Epidemiology

JG:DW:ES:mp

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Report Preparation

This Health Consultation for the Toastmaster Macon site was prepared by the Missouri Department of Health and Senior Services under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). Editorial review was completed by the cooperative agreement partner.

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